§6. HINT Computations of Helical Plasmas

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Behavior of magnetic islands and breaking of magnetic surfaces in finite pressure equilibria are important issues to be studied for helical plasmas. In the LHD experiments, actually, indications of shrink/growth of magnetic islands due to finite pressure effects are observed. Behavior of magnetic islands is determined by physics of the parallel component of the plasma current. Resonant magnetic fields induced by the pressure driven parallel currents, in particular, the Phirsch-Schlueter current and the bootstrap current, need to be analyzed in consistent with the pressure gradient profile which is perturbed by the island formation.

The three-dimensional (3D) equilibrium code HINT has been developed to answer the indeterminate question of whether or not a 3D magnetohydro- dynamic finite-beta equilibrium can keep clearly nested magnetic surfaces. The code does not a priori demand the existence of regularly nested magnetic surfaces [1,2]. We have numerically analyzed the island formation for the LHD (Heliotron) [3-5], Helias [5,6], and Heliac [7] configurations by using this code. One important discovery obtained was that magnetic surfaces are broken by the finite pressure effect in an actual helical configuration, and the breaking often imposes severer limitation on the equilibrium beta than the Shafranov shift. In the process of equilibrium calculation, we found one remarkable property of magnetic islands induced by the finite pressure effect; the islands, in some cases, show a property of `self-healing' that the islands tend to shrink as beta increases [5,6,8].

The HINT code has been modified to include the effects of the net toroidal current on the equilibrium in a fully consistent manner, especially the neoclassical currents such as the bootstrap current [9,10]. It has also been modified to treat a full-torus configuration and to improve the efficiency of the computations [11]. In addition, the code has been further modified so that coil currents can exist in the computation region (see Fig.1). So far in a HINT computation, the computation region has been carefully chosen so that coil currents were avoided form the region. This treatment has been unavoidable to relax the numerical restriction, which is called the Courant condition, caused by high speed Alfven wave due to the existence of large amplitude magnetic field near the coils. A new numerical technique has been developed to overcome the restriction.

As a result of development of those modifications, the HINT code is now used to analyze behavior of magnetic islands observed in the actual experiments, such as the n=1 island in LHD.

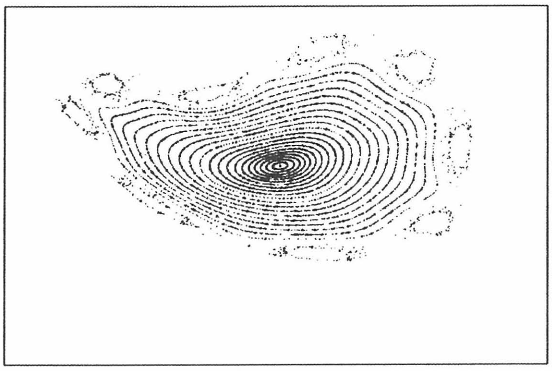

Fig.1 Computation of finite pressure equilibrium of helical plasma by using the modified HINT code, in which the coil current exists in the computation region.

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